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Systems analysis of the bioeconomy as a path towards low carbon development in Colombia

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Introduction

Regional climate assessments have reported a variable contribution of biomass to the low carbon development of the Colombian economy (Calderón et al. 2016). National bioenergy roadmaps have been mostly qualitative, with few exceptions (e.g. Gonzalez-Salazar et al. (2016)). Neither of these approaches could thoroughly address the complexity of the bio-based economy (BBE); in the wider context of energy and chemicals supply and emission mitigation. Recent systems analyses of the BBE (e.g. Lap et al. (2019)) lack a representation of palm oil value chains; which are relevant for Colombia.

Research Objective

- **Explore the potential role biomass can play in the supply of energy and chemicals and emission mitigation in Colombia to 2050**
- **Assess the competitiveness of advanced value chains; including Bioenergy with Carbon Capture and Storage (BECCS), renewable jet fuels (RJF) and bio-chemicals.**

Methodology

We use TIMES **techno-economic optimization** model. We observe the deployment of biomass in different sectors in competition with other value chains (fossil, other renewables, CCS; Figures 1 and 2). We use the Shared Socioeconomic Pathways (SSP) scenario analysis framework to analyze technology development and mitigation policy scenarios (SSP1 vs. SSP3) and land availability scenarios for biomass (BioHi vs. BioLo).

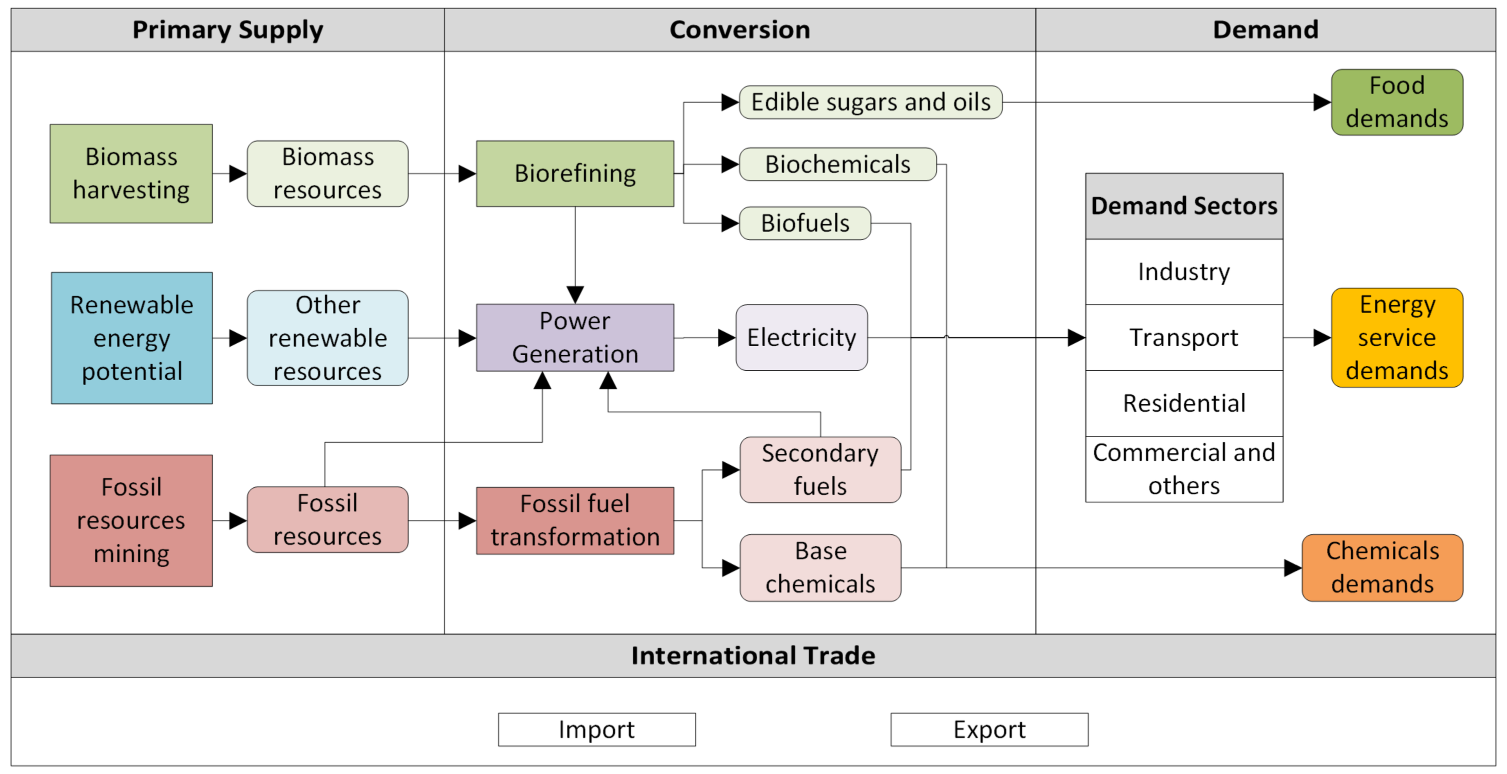

Figure 1: Overview of the reference energy system (Younis et al. under review)

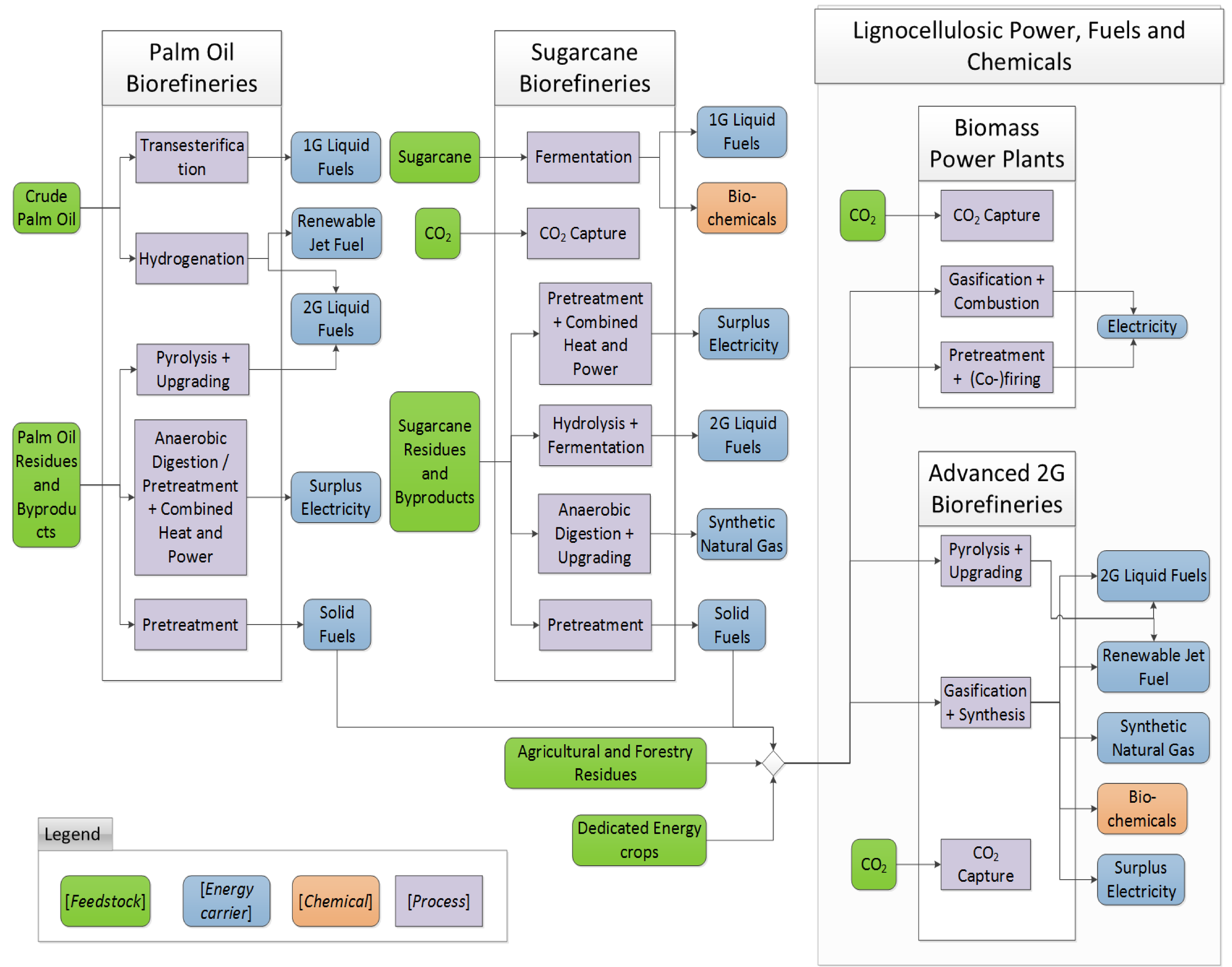

Figure 2: Overview of bio-based conversion technologies (Younis et al. under review)

Main findings

Biomass can play an important yet variable role in Colombia (Figure 3). Novel transport biofuels and biochemicals can be competitive, even without mitigation policy. High technological learning can shift biomass from industrial heat to electricity.

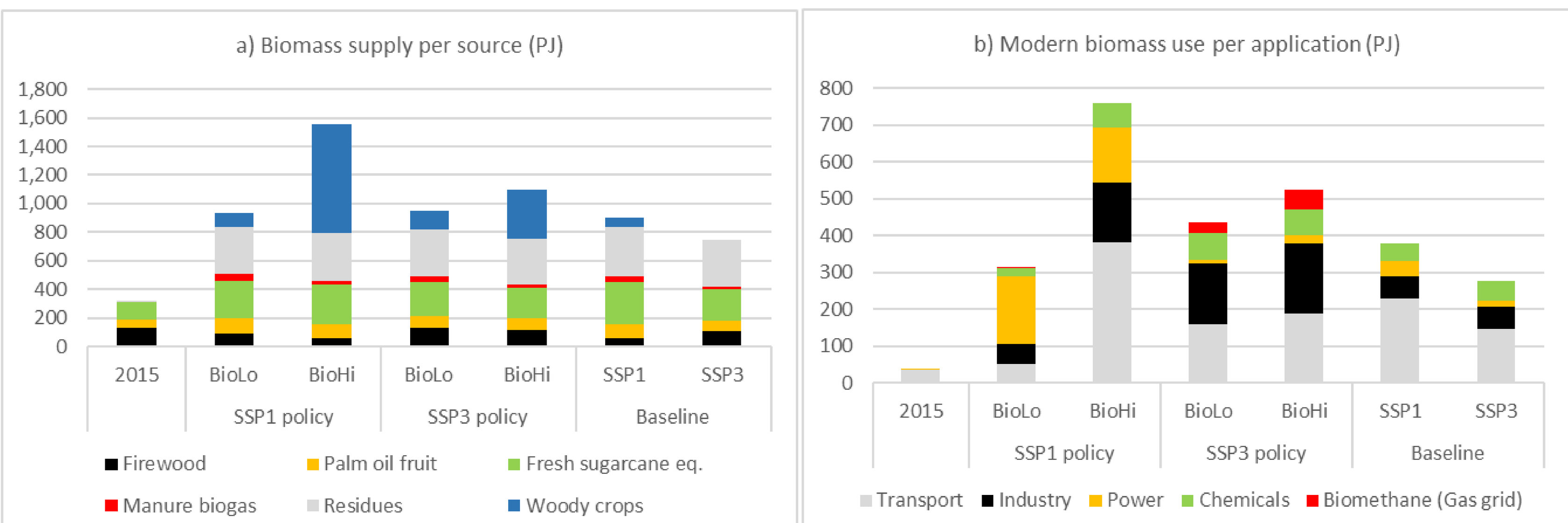

Figure 3: An overview of biomass sources (a) and applications (b) in 2015 & 2050 scenarios

Insights into deep decarbonization (SSP1 ~1.7 Gt-CO_2-eq. cumulative avoided emissions 2015-2050):

- The availability of (land for) biomass (~2.6 Mha) can reduce the annual energy system cost by up to 11 billion $/y . Alternatively, substantial investments in power infrastructure and electric mobility will be required (Figure 4).

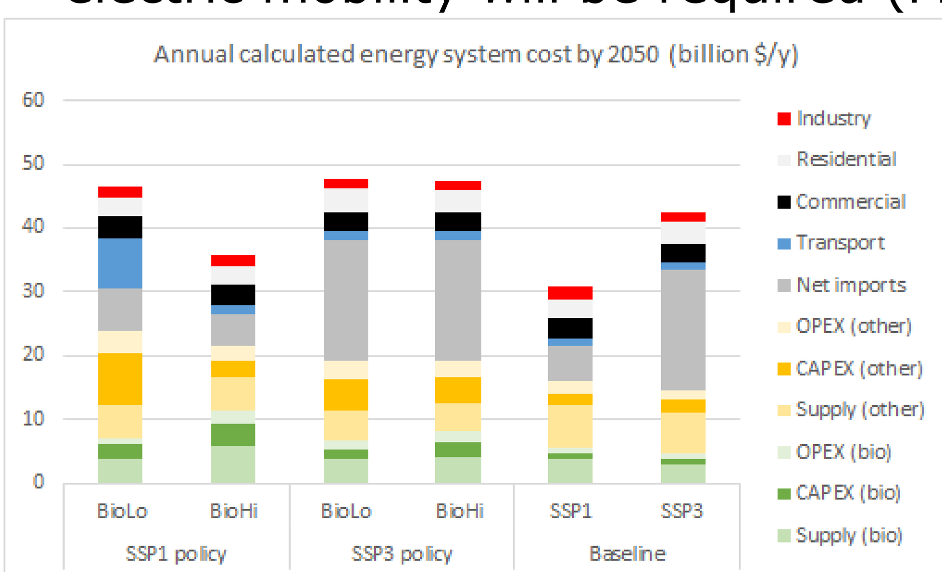

Figure 4: Annual energy system cost by 2050

- BECCS technologies can contribute up to 24-29% of the cumulative avoided emissions (Younis et al. under review).

Future research

- Implications of land use for the biomass potential: Regional distribution of energy crops and residues and supply costs.
- Implications of the high penetration of intermittent renewable energy sources for the power system stability.

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